

Department
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What makes a city smart?
A new concept of city based on
sustainability and innovation

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Introduction

In a fast-evolving world, where society is highly influenced by continuous development and by the enhancement of technologies, the role of sustainability and of creating a comprehensive environment is getting more and more fundamental for innovation. The dissertation underlines this rapid and evolving ecosystem and era in which all of us are facing challenges and overcome opportunities.

Therefore, the first chapter focuses on sustainability and its impact on society and especially in particular ecosystems called “smart cities”. It underlines how sustainability is interconnected with the environment and society, with its economy as a whole. Besides, it embraces the Sustainable Development Goals of the UN and particularly Goal number 11 which illustrates the importance of implementing infrastructures and cities in general. Moreover, the relationship between sustainability and the new disruptive pandemic of COVID19 which importantly has affected society and has set the world in a tough situation is faced as well.

Secondly, it has been analyzed the external environment and the context in which society is more and more connected to urbanization and the concept of the city. Moreover, it is pointed out why cities are getting smarter and by describing the different layers that define the smart city: technologies, applications and people. Technologies such as IoT, ICT and Big data technologies are nowadays fundamental for innovation. Nonetheless, the application of these technologies in different branches of life is enhancing every initiative. But in order to create an ecosystem that thrives on better opportunities, people engagement is necessary. This chapter highly determines the core of the dissertation and emphasizes the role of each pillar in the social environment.

In conclusion, the importance of management in an ecosystem like Smart cities is highlighted. Starting from the most common challenges that a city must undertake, it arises the most relevant issues that cities are facing. Furthermore, it is stressed the importance of success factors that have led to cities to overcome opportunities in becoming Smart cities. Moreover, the Smart City Management Model is analyzed, which clearly defines a plan of action in order to operate in a sustainable ecosystem. Through the management model, it is implemented a new vision of taking care of society and inhabitants. As far as Business Model is concerned, it is emphasized how to achieve success factors and total welfare of the society. For this reason, two case studies have been analyzed: Stockholm and Barcelona. These cities are two of the most innovative and dynamic cities in Europe. As a matter of fact, together with the city of Lyon, they have established a new project called GrowSmarter, a sustainable initiative to enhance people’s livability.

Chapter 1: Sustainability

Sustainability and its interconnection with the economy

Nowadays, the society has been running through a disruptive and dynamic world. In these last decades, aspects such as sustainability have been strongly accentuated and have started to become an essential layer of society. As a matter of fact, sustainability is all about how natural systems work and how the world can become an eco-friendlier world. Moreover, it is fundamental to underline the cooperation between human civilization and ecology to enhance a more modern way of life. Sustainability and sustainable development focus on balancing our need to enhance development both technologically than economically, and the need to protect the environments in which we and others live. Sustainability doesn't deal only with the environment; it also embraces our health as a society in ensuring that no people or areas of life that suffer are affected negatively by environmental issues. Sustainability concerns with three macro pillars that have been identified during the World Summit on Social Development in 2005: economic development, social development, and environmental protection.

Economic development

The supply and demand market in nature and modern life requires a lot of resources every single day. Economic development is about ensuring people to enhance the quality of life, especially in the developing world, and reducing the financial burden and “red tape” of doing the right thing.

Social development

Access to basic resources without compromising the quality of life is one of the pillars of sustainability. The most important element is education: encouraging people to participate in environmental sustainability and teaching them about the effects of environmental protection through sensibilization.

Environmental Protection

Environmental protection is the third pillar and above all, the primary concern of the future of humanity. It defines the protection and the study of ecosystems, integrity and sustainability of our resources. Moreover, it deals with technology which will drive to a greener future. The EPA (environmental protection agency) has focused on developing technology and biotechnology as they

are the key to sustainability. Indeed, it is important to sustain the environment in order to prevent damages caused by the technology process.

For instance, in June 2012, a strategic framework has been developed by the Green Building Council of Australia (GBCA) to underline the four principles by which sustainability is based. The framework aims to provide consistency and a common language around the definition of sustainable communities and to encourage innovation and development in future communities. Therefore, according to the GBCA: *“A sustainable community is the one that has aspirations for the future that acknowledge the challenges brought about by change. It is livable, resilient, diverse and adaptable,”* the GBCA said. *“It strives for lower carbon and ecological footprint. A sustainable community evolves through policy and collaborative practice that respects and embraces the aspirations of existing and future community stakeholders.”*¹

In order to meet a sustainable future, the GBCA established four principles:

- **Enhance livability:**

According to this principle, communities should provide infrastructures that reflect their broad socio-economic needs and to local services such as transport, food, and health.

Sustainable communities should be promoted and supported through partnerships, creating effective urban design and landscape plans that support an ecofriendly environment. Diverse and inclusive environments for all ages, abilities, cultures and socio-economic backgrounds of the community should be provided. The “built environment “should reflect resilience and should be able to adapt to changing social and individual needs, whether influenced by the economy, environment or culture.

- **Create opportunities for economic prosperity**

This principle highlights the promotion of sensibilization and education to enhance a sustainable environment. By creating employment opportunities that meet the needs of local and regional communities and facilitating access to them, communities will increase the production and procurement of goods and services. Moreover, it is fundamental to attract investments, providing key infrastructures that enable the flourishing of communities and businesses, and besides, encourage innovation through initiatives that promote efficiency and effectiveness.

¹ Sourceable.net. 2020. *Five Principles for Sustainable Communities – Architecture. Construction. Engineering. Property.* [online] Available at: <<https://sourceable.net/five-principles-sustainable-communities/>> [Accessed 7 September 2020].

- **Foster environmental responsibility**

To ensure a community is sustainable, it is vital to focus on its design, which should consider buildings, connectivity and the protection of valuable land uses such as agriculture. Communities, moreover, should create opportunities to renew and revitalize existing infrastructures, places, and buildings. To establish a sustainable environment, communities should seek development, planning flexibility, and adaptability of existing infrastructures. Furthermore, communities should also be able to adapt effectively to climate change and other environmental issues so that people's welfare is enhanced. The aim behind this concept of sustainability is to reinforce a sense of community identity and include local culture within the design. By constructing a connection with nature and encouraging welfare, integrated and safe public spaces that embrace the community is fundamental.

In order to upgrade communities' design, communities should conserve and celebrate cultural heritage and archaeological assets across landscapes, places and sites and, at the same time, create functional, vibrant, stimulating places that encourage people's welfare. Moreover, enhancing transport systems and promoting public health, encouraging accessibility, diversity which may reflect local values, will lead to a more comprehensive environment.

Figure 1.1 Sustainability environment



- **Demonstrate visionary leadership and strong governance**

Sustainable communities are not possible without the leadership and strong governance frameworks that reflect transparency, accountability and adaptability. Together with partnerships, leadership builds and achieves a shared vision and delivers stakeholder benefit. In applying this principle, communities should foster a sustainable culture and raise awareness among stakeholders and encourage sustainable behaviors by sharing information and allowing for continual improvement mechanisms.

Moreover, sustainability covers three different aspects of life that are interconnected with each other. Society, Economy and Environment are three pillars of the sustainable environment²: the world is an interconnected system of social, economic and environmental needs that must succeed over time. By balancing the economic development with the social responsibilities and protecting the environment, by reducing ecological footprint, a sustainable community can be achieved.

² Source: <https://www.econation.co.nz/sustainable-economy/>

Furthermore, the economy exists to support society and enhance human well-being. An ideal and sustainable economy is one that provides for the greatest amount of general well-being with the least amount of resource use and environmental exploitation. In economic terms, to be truly sustainable, the overall demand for ecological footprint must be less than nature's renewable supply of resources. Consequently, considering the dynamic and continuous development world, there are different ways to create a sustainable economy: the steady-state, circular economy, localized and solar economy.

Steady-state economy deals with the steadiness of the economy, in which there is no potential growth in the size of the economy but in the quality of the economy. This would lead to a wealthier and more sustainable, long term welfare.

Secondly, the circular economy represents the renewable vision of the economy. A circular economy aims to create a loop where nothing gets wasted but recycled back into production. By re-using, repairing, refurbishing and recycling existing resources, materials and products circular economy is the most sustainable vision of the economy. Using resources more efficiently will bring to new job opportunities and new economic development, preventing businesses, and reduce the total usage of gas emissions. A circular economy would avoid external costs by recycling resources and therefore would eliminate waste and environment exploitation. Moreover, the distribution of products, services and business systems would take on a new dimension. This would cause the products, services and business to evolve organically, improving in both effectiveness and efficiency. Collaboration and co-operation are fundamental for the better functioning of synergies and efficiencies.

Thirdly, modern economies have become centralized in big cities and they have also increasingly become dependent on globalization, exploiting all possible resources. In the future, when fossil fuels will run out, energy will be sold at a so high price that economies will prefer to source locally. This type of economy would lead to decentralization and diversification of economic activity, restoring both biological and cultural diversity. Moreover, it would lead to rebuilding social interdependence and cohesion and to a deeper connection between people and nature.

Lastly, the solar economy is a non-carbon economy. This means no fossil fuel emissions, that lead to climate change and that are not an infinite resource. This type of economy is based on renewable energies. Facing that, climate change is a threat to all of humanity and indeed the whole biosphere: a more conscious usage of solar and other renewable energies could lead to welfare.

1.2 U.N. Sustainable Development Goals 2030

As sustainability discussion and awareness advanced, the United Nations in 2015 has developed a set of goals that provide a shared blueprint for welfare and prosperity for people and the earth. The “2030 Agenda for Sustainable Development” is characterized by 17 core goals called Sustainable Development Goals (SDGs), which through them a country should enrich its strengths and undermine its threats.

Figure 1.2 U.N. 17 Sustainable Development Goals



These 17 Goals include: 1. No poverty; 2. Zero hunger; 3. Good health and wellbeing; 4. Quality education; 5. Gender equality; 6. Clean water and sanitation; 7. Affordable and clean energy; 8. Decent works and economic growth; 9. Industry, innovation and infrastructure; 10. Reduced inequalities; 11. Sustainable cities and communities; 12. Responsible consumption and production; 13. Climate action; 14. Life below water; 15. Life on land; 16. Peace, justice and strong institutions; and 17. Partnerships for the goals³. These goals are highly supported and recognized in the whole world as the fundamental goals for social development. SDGs have related thematic issues including water, energy, urbanization, transport, oceans, science and technology. At five years since the adoption of these new goals, according to the Annual Sustainable Development Goals Report, changes have been made in some selected areas, such as improving family health, expanding access to electricity and increasing gender equality in government. The SDGs are extremely important because they are a powerful advocacy platform to enhance prosperity and welfare. Therefore, society and all the environment should focus on these 17 SDGs to enhance the total welfare of the world. By improving each factor, sustainability will be implemented and with it, the ecosystem and environment in which we live. Everyone must reach these ambitious targets. In order to achieve the SDGs in every context, the creativity, know-how, technology and financial resources from all of society are necessary.

³ Source: www.un.org

1.3 Sustainability challenge: a focus on COVID-19

Before COVID-19, the world was highly focused on increasing environmental problems and social issues due to controversial economic policies and global trade. Sustainability has been a term and concept underlined to bring balance and create responsibility for economic activity and development.

During the pandemic, the economy has been affected by the disruptive drift that the whole world has made. The economy at its record lows, social issues are arising, and global animal species have started to become threatened. The global economic fallout from COVID-19 has been devastating most people have been impacted largely by losing their job and so get unemployed. Large industries, such as the airline industry, have begun to suffer insurmountable losses. Moreover, the new reality for the education system that COVID-19 through the use of online learning has been successful, but it can be made possible only through a wealthy situation that has access to a stable internet connection and technology that enables this type of learning. This pandemic is now contributing to the collapse of one of the three pillars: society. Comparing to other industries that might have responded positively to face the challenges of the COVID-19 pandemic, a sustainable business does not have clear the long-term direction of its business and when the pandemic will stabilize. The COVID-19 pandemic has unchained an unpredictable crisis, causing further disruption to Sustainable Development Goals progress, with the world's poorest and most vulnerable affected the most. Using the latest data and estimates, this annual report on progress across the 17 Goals shows that the poorest (including children, older persons, migrants and refugees) who have been hit the hardest by the COVID-19 pandemic.

The pandemic we are facing has not only affected the physical health of hundreds of thousands of people: COVID-19 affects physical health most directly, but it has influenced even mental health. This includes economic instability, domestic violence, use of drugs, derailment from the regular schedule, and depression created even by phenomena such as lack of sunlight. These factors have contributed to creating a great impact on sustainability and people's welfare. Physical and mental health are closely related, and one taking a considerable hit will greatly impact the other.

Moreover, the UN Secretary-General Antonio Guterres has announced: *“As Member States recognized at the SDG Summit held last September, global efforts to date have been insufficient to deliver the change we need, jeopardizing the Agenda's promise to current and future generations.*

Now, due to COVID-19, unprecedented health, economic and social crisis is threatening lives and livelihoods, achieving of Goals even more challenging.”⁴

So, due to COVID 19, most of the objectives have been disrupted and the due date of 2030 has been delayed. This social, economic and health crisis has led to different challenges, most of all towards sustainability. The latter has experienced different changes, but, even if long term objectives have been affected negatively, disrupting the “work” already done, short term goals have been positively affected. To contain the transmission of the virus, many countries have adopted dramatic measures to reduce human interaction, such as strict quarantines, prohibiting private and public gatherings, restricting private and public transportation and encouraging social distancing. For example, all Italian cities were locked down and so, various types of economic activity were strictly prohibited. Thanks to this lockdown, cities have experienced a considerable improvement in environmental quality. For instance, where pollution once hindered the view of the Italian Alps, the mountain range is now clear to see. Moreover, even China, where the outbreak started, showed a marked reduction of air pollution after the government imposed the lockdown, following the same pattern. The European Space Agency (ESA) affirmed that a particularly important decline in emissions of nitrogen dioxide, a noxious gas emitted by power plants, cars and factories, over the “Pianura Padana” in northern Italy. *“Although there could be slight variations in the data due to cloud cover and changing weather, we are very confident that the reduction in emissions that we can see coincides with the lockdown in Italy causing less traffic and industrial activities,”*⁵ Claus Zehner, head of the agency’s Copernicus Sentinel-5P satellite mission, said in a statement. Therefore, the coronavirus pandemic has brought changes to all the ecosystems, both negatively than positively, leading the world to various challenges.

1.4 The Smart city solution

A clear example of a sustainable environment are Smart cities: a reflection of sustainable principles and a connection to urban society. Smart cities embrace in their simplicity technology, innovation and development and with a strong connection with the environment try to overcome the dichotomy created by nature and technology. As a matter of fact, these cities have the aim, through innovation, to enlarge their accessibility and increase people’s welfare.

⁴ United Nations Sustainable Development. 2020. *Sustainable Development Goals Report*. [online] Available at: <<https://www.un.org/sustainabledevelopment/progress-report/>> [Accessed 10 September 2020].

⁵ U.S. 2020. *Air Pollution Clears in Northern Italy After Coronavirus Lockdown, Satellite Shows*. [online] Available at: <<https://www.reuters.com/article/us-health-coronavirus-italy-pollution/air-pollution-clears-in-northern-italy-after-coronavirus-lockdown-satellite-shows-idUSKBN2102X4>> [Accessed 10 September 2020].

De facto, the Smart Cities have the potential to make a significant contribution to urban sustainability, by exploiting information and communication technology (ICT) to gather urban data and improve performance and management. As a matter of fact, sustainability has an important role in the management of urban society. It represents one of the core factors of every smart city. Without a sustainable footprint, Smart cities are not enabled to develop over time. Sustainability, as for technologies, represents the fundamental steps that enclose the concept behind the smart cities. By leveraging modern tech, sustainability can enormously improve welfare and urban life in its complexity.

By creating a smart environment, smart cities focus especially on minimizing the ecological footprint of a city without losses in other factors such as mobility and quality of life. These factors include the preservation of green areas and the reduction of ground sealing. An example of the urban greening process is a Plywood Skyscrapers, modern constructions made of glass, steel, concrete and wood. Wood is now taking a center stage as a light and flexible material and moreover, the wood-based housing can serve as a CO2 sink (trees actively absorb carbon dioxide and lock it away in their wood). So, timber skyscrapers are popping up across the world, from Vancouver to Vienna, becoming the next generation of skyscrapers. Timber is one of the most advanced building materials of the 21st Century, but there were already infrastructures made of wood. The Sakyamuni Pagoda of Fogong Temple in China is one of the oldest wooden infrastructures. Thanks to skillful craftsmanship and powerful design, the pagoda is still standing after 900 years. With 67m of height, it remains the tallest wooden building in the world.

During the 20th Century, men have exploited the resources that the earth has been offering in millenniums. According to Anthony Thistleton, “*The 20th Century was the concrete age, it was all about the dominion of man over nature*”⁶. While in the 20th Century the society has fully concentrated on taking advantage of nature, the 21st Century is a new challenging era, which embraces the concepts of sustainability and resilience. Through the implementation of smart solutions, society could highly improve its ecosystems and could enhance the total livability of societies and, more specifically, of cities.



Figure 1.3: Goal 11: sustainable cities and communities

⁶ Gorvett, Z., 2020. 'Plyscrapers': The Rise Of The Wooden Skyscraper. [online] Bbc.com. Available at: <<https://www.bbc.com/future/article/20171026-the-rise-of-skyscrapers-made-of-wood>> [Accessed 11 September 2020].

As a matter of fact, according to Goal 11 of the Sustainable Development Goals, should enhance sustainable cities and communities to achieve welfare⁷. More than half of the world population lives in cities. By 2050, the UN has predicted that two-thirds of the population will live in an urban context. Therefore, sustainable development cannot be achieved without transforming the way we build and manage urban spaces. Cities should become “human settlements, inclusive, safe, resilient and sustainable”⁸.

Making cities sustainable is about creating new opportunities, new businesses and building new resilient societies and economies. This involves transport, creating new green spaces, and improving urban planning and management.

The goals of this section of Sustainable Development Goals are various. By 2030, the UN has set to support positive economic, social and environmental links between urban and rural areas by strengthening national and regional development planning. Moreover, the UN has ensured that by 2030 will give support the least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings using local materials.

In conclusion, the most relevant solution to enhance welfare, sustainability and livability is shaping a new approach of living the communities. The smart city is the solution that combines the idea and concept of creating a more livable future.

⁷ Source: <https://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-11-sustainable-cities-and-communities.html>

⁸ Sdgs.un.org. 2020. *Goal 11 | Department of Economic and Social Affairs*. [online] Available at: <<https://sdgs.un.org/goals/goal11>> [Accessed 11 September 2020].

Chapter 2: Introduction to Smart Cities

... “A smart city is understood as a certain intellectual ability that addresses several innovative socio-technical and socio-economic aspects of growth. These aspects lead to smart city conceptions as “green” referring to urban infrastructure for environment protection and reduction of CO2 emission, “interconnected” related to revolution of broadband economy, “intelligent” declaring the capacity to produce added value information from the processing of city’s real-time data from sensors and activators, whereas the terms “innovating”, “knowledge” cities interchangeably refer to the city’s ability to raise innovation based on knowledgeable and creative human capital.”...⁹

The term “smart city” was initially used in the 1990s. At that time, the main target was on the importance of new ICT concerning modern infrastructures within cities. The California Institute for Smart Communities was among the first to specialize in how communities could become smart and how a city could be designed to implement information technologies. Nowadays, cities face complex challenges to fulfill objectives dealing with socio-economic development and people’s welfare. The concept of "smart city" may be a response to those challenges. Nowadays cities are upgrading their vision by creating a new and disruptive idea of living. Smart cities aren’t just a concept or a dream of the future, a smart city is a new promise of life and availability of openness through a sustainable key. Smart cities represent a real visionary urban development model based on the application of human, collective and technological capital for the development of urban society.

The concept of the “smart city” promises to solve many urgent issues that progressive urbanization faces today through digitalization. Smart cities are therefore highly relevant for political decision-making, administrative agencies, and civic organizations.

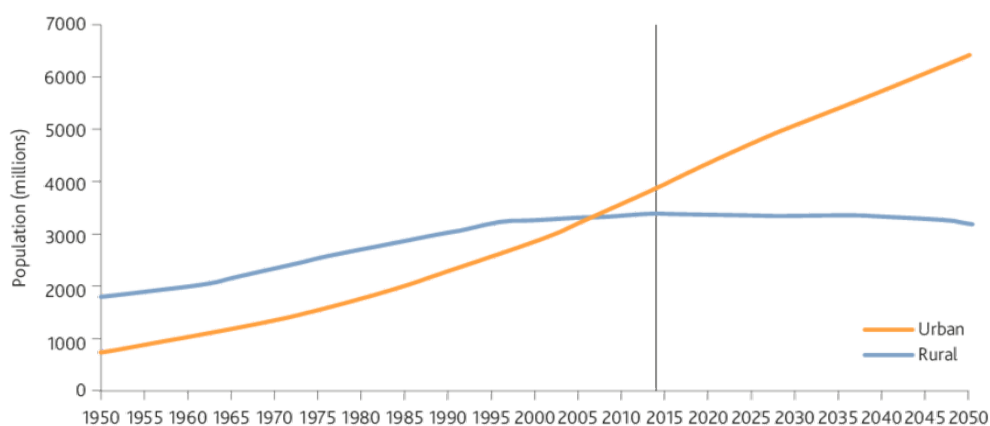
Moreover, smart cities offer great potential for corporations in the field of technology, real estate, telecommunications, energy supply, automobility, sensor systems and data analytics. As a matter of fact, it is not surprising that highly innovative companies such as Cisco, IBM, Telekom and Google are every day investing in smart city development. Also, the major characteristics used to determine a city's smartness include: the technology-based infrastructure; the environmental initiative; the humans who live and work within the city and utilize its resources. Besides, a smart city's success depends on its ability to create and maintain a digital, data-driven environment connected by a strong relationship with the government.

⁹ Albino, Vito & Berardi, Umberto & Dangelico, Rosa. (2015). Smart Cities: Definitions, Dimensions, Performance, and Initiatives. *J. Urban Technol.* 22. 3-21

2.1 Urbanization

Urbanization was developed in countries of the West for 200 years. Since the Industrial Revolution, a period in which machine-based manufacturing grew rapidly, cities have grown promptly. While economies were previously dependent on manual labor, as technological innovations flourished, began to change. People decided to move to the cities to find a job and rapidly, cities began to grow exponentially. Today, the most exponential city growth is occurring in the less developed and poorest countries of the world. In the most industrialized ones, on average, three out of four people already live in an urban area. In contrast, in the less developed regions of the world, more than two-thirds of people still live in rural areas. Where most of the economies in rural areas are agriculture-based with little cash flow, in the cities, people earn cash from sales and work. As the world's population increases, the urbanization process is pushing more and more people to “emigrate” into the cities. Such exponential rates of urbanization and intense poverty of large urban populations exploit resources. Nonetheless, to poor, landless people, cities offer visions of opportunity. The resulting, particularly in developing countries, represents one of the world's greatest social and economic challenges. As a matter of fact, cities are the projection of the living life of the future. The “century of the city” has been a preoccupying theme along with every scope, from politicians to business developers. Today, 55% of the world's population lives in urban areas, a proportion that is expected to increase to 68% by 2050. The projection shows that urbanization, the gradual shift of people living from rural to urban areas, combined with the overall growth of the world's population will end up in an increase of urban areas by 2.5 billion people in 2050 (mostly in Africa and Asia).

Figure 2.1 Urban and rural population of the world, 1950-2050 (Source UN, 2015)¹⁰

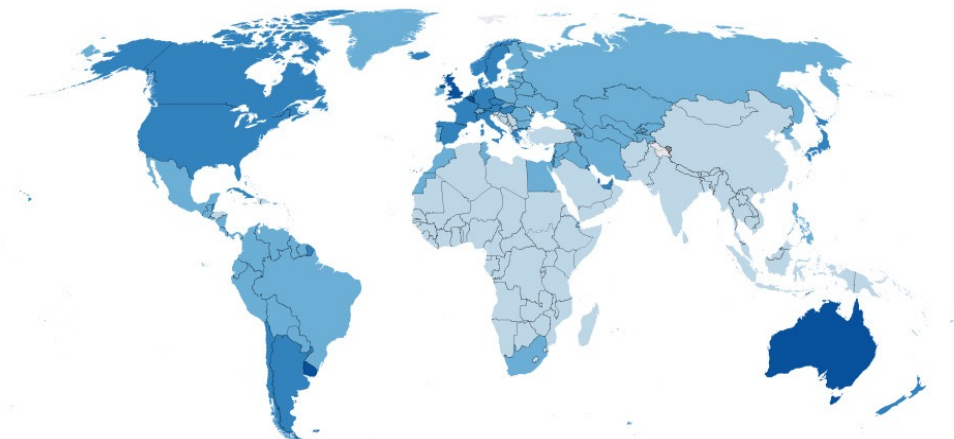


¹⁰ Gassmann, O., Böhm, J. and Palmié, M., 2019. *Smart Cities*. Emerald Publishing, p.5.

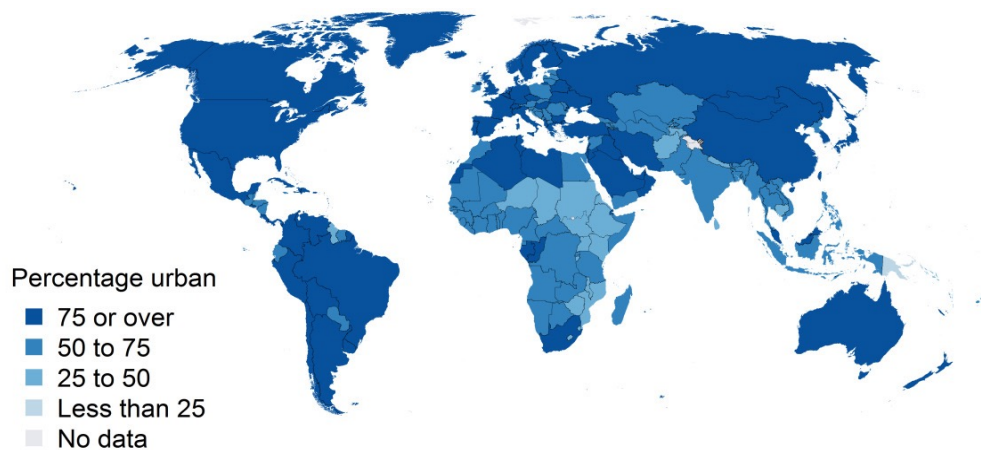
As cities get more populated, the necessity of implementing infrastructures and technologies rapidly gets more crucial and unavoidable. The challenges confronting cities vary significantly depending on the region and the city's size.

According to “World Urbanization Prospects” (United Nations,2018), Africa has the lowest level of urbanization with an annual growth rate of 4%. The number of cities in Africa with more than one million inhabitants has grown rapidly from 28 in 1995 to 43 in 2005 and 59 in 2015 and it is expected to grow more in the next decades. In the Asia-Pacific region, about half of all people are living today there. As a matter of fact, Asia is experiencing rapid urbanization, largely due to the industrialization of China and India. According to global city rankings, based on GDP, Shanghai is expected to rise from 25th place in 2008 to 9th place in 2025. In contrast to Africa and Asia, North America is experiencing relatively moderate population growth. However, this growth is not uniform. There are divergences on the growth rate of who is living in cities and who is not. Us southern cities in particular are still growing due to the high proportion of immigrants which balances out the weak growth of the rural regions. Last but not least, European urbanization patterns are similar to those in the United States, with both differing sharply from demographic developments in the rest of the world. Various trends in Europe have led to the conception of the city to evolve constantly. In Europe, growing populations are not a major factor in urban development: during the last century one-third of European cities experienced a population decrease while the other no significant change. The degree of urbanization slightly changed from 73% (2010) to 75% (2020).

Figure 2.2 Percentage of the population residing in urban areas, 1950 and 2050¹¹



¹¹ Population.un.org. 2020. [online] Available at: <<https://population.un.org/wup/publications/files/wup2014-report.pdf>>



The growth of urban conglomerates is already causing the importance of countries to diminish. This trend towards the increasing importance of cities, which may surpass the significance of nations, not only entails bright prospects for urban areas but also involves great challenges.

2.2 What makes a city Smart?

Smart cities collect data and apply digital technology in order to improve the quality of life of people. Thus, instantaneous data give agencies the ability to watch events as they happen, understand how demand patterns are changing, and respond with efficient solutions. In particular, smart technologies develop the nature and economics of infrastructure. They reduce the cost of assembling information and, with a massive volume of data, city governments, employers, and citizens can find new ways to optimize urban life. Some smart solutions both respond to demand and involve the people in evolving it. The aim is not only a more livable city but also a more engaging and captivating business environment to enjoy. As a matter of fact, cities from all over the world are undergoing major changes to make our everyday lives better, more efficient, and more ecofriendly.

Even if citizens worldwide manage and seek different needs, by massive and conscious usage of technologies Smart Cities are experiencing high-value improvements.

According to one of McKinsey's report ("Smart Cities: Digital solutions for a more livable future", June 2018), three layers work together in order to make a city "smart".

First is the technology layer, which deals with several sensors connected by high-speed communication networks. Sensors take constant information about data such as traffic flow, energy consumption, air quality, and many other aspects of daily life.

The second layer consists of specific applications. Translating basic data require the right tools. and knowledge, and so it is necessary for the distribution of providers and in-app solutions. Perhaps the most effective way to understand what a smart city can be is to look at the full range of currently available applications. Tools are available in multiple concerns: security, mobility, health, energy, water, waste, economic development, housing and community.

The third layer regards public usage. Many applications succeed only if they are widely adopted and manage to revolutionize behaviors. As a matter of fact, the social impact should be one of the fundamental steps of an innovation that will lead to a “smarter” city. Therefore, these three layers are interrelated and co-work to enhance the development of a Smart City. On the other hand, none of them would have been enough to flourish the development of Smart Cities without the reciprocal contribution of each layer. Moreover, in this third focus, which is still a minority approach in the world, the quality of life experienced and felt by citizens is the priority objective. Sustainability is then identified in its human and moreover, subjective dimension; it is based on population profiles, difficult to measure, creating a heterogeneous scenario.

2.3 Technology Base

Smart cities nowadays generate oceans of data, in all their complexity and scope.

By observing the insights in all that data helps governments respond to various situations, allocate resources strategically, and plan the future. Furthermore, gathering information and providing it into the hands of individuals and companies empowers them to manage situations, make better decisions and play an effective role in shaping the city’s overall performance. As cities get smarter, they become more livable and more responsive to today’s environment. What technology base can implement in the urban environment is more than the glimpse that nowadays offer. Rapid advances in smartphone penetration, connectivity, the Internet of Things, analytics and machine learning have paved the way for disruptive innovation. A smart city is also defined as a city that interconnects the physical infrastructures with ICT infrastructures to leverage the co-existence of these two worlds. As a matter of fact, through a large deployment of IoT, Smart cities integrate into urban infrastructure forming a "digital skin" around them. All those technologies involved, deeply affect urban society and all the interconnections of the day by day routine. Moreover, these applications in smart cities are interrelated. This means that none of them could have been an innovation without the reciprocal application of it. The range of new applications is constantly expanding, and their capabilities are becoming more sophisticated.

Before a city can deliver applications, it has to be able to create, identify, and analyze a massive set of data in complex infrastructure systems. So, the technology base consists of three elements, all of which support the applications of today as well as those to be added in the future.

Firstly, cities need a layer of sensors and devices throughout the physical environment. The most engaged of the technologies is the Internet of things (IoT), which is a system formed by interrelated devices, physical and digital machines that also can transfer data without a physical connection, but a more digital data exchange. The definition of the Internet of things is evolving continuously due to the convergence of various technologies, real-time data analysis, machine learning, physical sensors and embedded systems.

Secondly, cities need robust communication networks. In the past few decades, information and communication technologies (ICT) have provided society with a vast range of new communication capabilities. For example, people can communicate instantaneously with others in different countries using technologies such as instant messaging or videoconferencing. Social networking websites like Facebook and Instagram allow users from all over the world to remain in contact and communicate regularly. As a matter of fact, the situation we have been through due to coronavirus is a clear example of the exploitation of communication improvements. During the period of quarantine, people all over the world has communicated and has worked through ICT technologies leading towards a “smarter” world.

Modern information and communication technologies have implemented the way by which people can communicate with others across the world as if they were living next door. For this reason, ICT is an in-depth analysis of how modern communications are affecting society.

Moreover, ICT encompasses old technologies alongside the sphere as well as the mobile one powered by wireless networks. It also includes ICT elements such as artificial intelligence and robotics. In addition, the list of ICT components is exhaustive, and it continues to grow such as free Wi-Fi coverage for residents and visitors across a city. As a matter of fact, smartphones are an important element: they act as mobile sensors as their owners move through the city with them. Phones generate all types of data, and they are the most common means for users to interact with applications.

Thirdly, open data portals are important platforms for innovation. City governments hold bundles of potentially valuable data in their infrastructure systems, public records, and the environment. Many cities around the world now make significant amounts of their information public, from health inspections to school performance and neighborhood crime statistics.

Big data and data science are closely entwined. While data science deals with data analysis, big data is used for analyzing information which will be used for implementing decisions and for facing strategically business situations. Converting data sets into standardized, sharable formats and making

them available on easy-to-use public portals gives external developers the raw material for making application and in particular, provides the fuel that “trains” the AI systems, enabling them to deploy more sophisticated functions. As a matter of fact, companies are developing availability, flexibility, and openness to perceive this new ecosphere of growth. Analytics enables organizations to manage plenty of data, sustain competition in the market, manage risk, and enhance customers. According to the ex-Vice President of Microsoft, Susan Hauser: *“big data has the potential to change the way governments, organizations, and academic institutions conduct business and make discoveries, and it’s likely to change how everyone lives their day-to-day lives.”*¹²

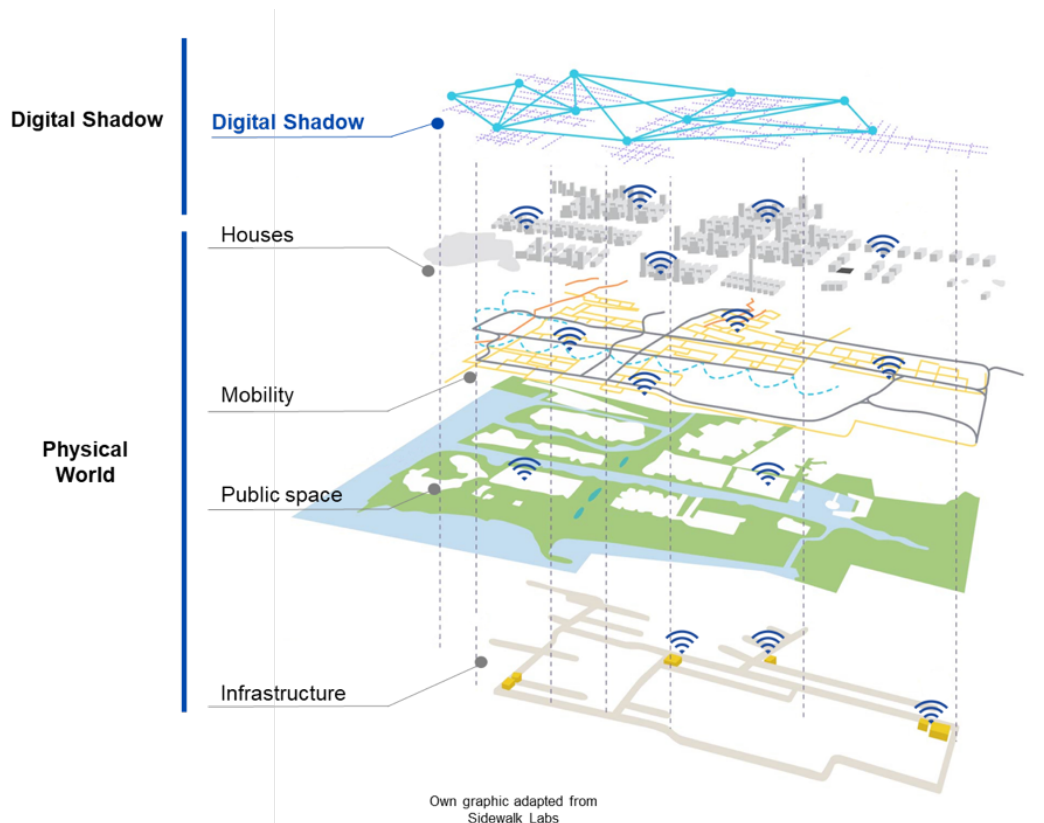
Besides, data visualization is the remarking task that data scientists need to efficiently perform, for example, data analysts must effectively visualize and present an organization’s comprehensive data by turning information into intelligence. Industries such as Google, Facebook, Twitter, etc. have adopted data visualization to ease data distribution. They have experienced positive outcomes in terms of a greater return on investments (ROI) and business stability.

The data of an organization is the most strategic impersonal asset that a company can own in order to derive the best data-driven opportunities. Many sectors are affected by Big Data analytics but mainly in the communications domain that has benefitted so far through this Big Data business.

To accomplish the objectives of smart cities, technologies are fundamental. The objectives that a city should focus on such as reduce resource input, high quality of life and a mostly digital solution are the basis to the called “digital shadow” of a city.

¹² Ey.com. 2014. *Big Data: Changing The Way Businesses Compete And Operate*. [online] Available at: <[https://www.ey.com/Publication/vwLUAssets/EY_-_Big_data:_changing_the_way_businesses_operate/\\$FILE/EY-Insights-on-GRC-Big-data.pdf](https://www.ey.com/Publication/vwLUAssets/EY_-_Big_data:_changing_the_way_businesses_operate/$FILE/EY-Insights-on-GRC-Big-data.pdf)> [Accessed 13 September 2020].

Figure 2.3 The digital shadow of a city ¹³



2.4 Applications and Public Usage

Smart city concept, without the applications the application layer and the public usage layer would be only a utopic vision. A smart city develops its digital shadow in six different service areas, with the help of digital technologies that are often embedded within innovative business models. These six areas are: smart living, smart economy, smart government, smart people, and smart environment.

Smart living embraces an area based on the improvement of quality of life. Different factors contribute to establish this area, such as: cultural establishments, healthcare, security, housing amenities, social cohesion, tourism attractiveness and education. Information and communication technologies have already been applied in many of those fields and are continuously gaining importance.

As a result of the pandemic in which we have been through, people have disruptively changed the way of living. People have shifted from a more interactive way of living to a more digital one. Even

¹³ Gassmann, O., Böhm, J. and Palmié, M., 2019. *Smart Cities*. Emerald Publishing, p.30.

companies that used to be “digitally lazy” as well as schools and universities will now have to step up in their digital game: Video conferencing, document sharing, cloud solutions, information security. Businesses across all industries, whether they like it or not, will have to use digital technologies to keep their operations running that will lead to a steep learning curve. Companies that until now have relied on outdated solutions will now experience the efficiency of digital infrastructures. Leaders who so far abstained from allowing people to work from home will notice that are getting more productive if employees can work within their environments. Moreover, new improvements have been actualized by a development in the healthcare system. As a matter of fact, now artificial intelligence is used to see if people by a scan of the chest are positive or not to the coronavirus. This virus is not only seen as a death threat but a challenge to exploit the technologies now possible. Even security such as police work through data-driven analysis has now emerged as a challenge. Therefore, practicing self-isolation or social distancing is increasingly developing products and services ranging from education to entertainment, from shopping to cleaning and health. The consumption of internet data, which is the most relevant challenge, is therefore growing rapidly.

In addition, Smart Economy is an important service area of a smart city environment. The components involved in the dimension share the objective of increasing a city’s competitiveness. Many smart cities try to deploy and establish as many innovation ecosystems such as start-ups and other established companies that have an interest in innovation and implementing sustainable business models. The idea of the smart economy often receives only limited attention in smart city concepts. This service area offers great expansion potential and represents a rich source of innovative ideas and business models. A smart economy encompasses the application of novel technological solutions to enhance entrepreneurship, productivity and local and global networking.

Nevertheless, Smart Mobility is a core element of smart city initiatives. Various innovative solutions in this area have already progressed to an implementation stage. Existing projects are already actualized such as: traffic guidance systems, parking spaces with sensors, congestion forecasting integrated with intelligent traffic lights, car and bike-sharing systems and autonomous public and private transportation. Smart cities must offer effective smart mobility solutions while encouraging innovation, facilitating a comprehensive ecosystem, and overcoming sustainability goals. These challenges identify the changing landscape of urban mobility and how it is rapidly evolving. Strategies to meet city mobility challenges and solve urban mobility problems change by city. As a matter of fact, cities from all over the world face different needs compared to each other, thus enabling the possibility to implement technologies.

As for examples of smart mobility, Intelligent Traffic Management Solution (ITS) provides decision support enabled by artificial intelligence. This smart city mobility solution enables intelligent traffic management services such as change of traffic light phases, road user information, and dynamic changes in traffic frequency in order to minimize vehicle emission levels and reducing traffic congestion in residential areas. Most of all micro-mobility is changing the entire urban mobility system which includes systems of shared bikes and electric scooters. According to CityLab "*is the hottest tech in transportation*"¹⁴. For example, eCooltra is a European innovator in scooter-sharing with more than 3,000 electric scooters deployed in five cities. By using the eCooltra app, customers can unlock a scooter and start a ride, even only for a few minutes of usage. This e-mobility solution has the objective to improve people's quality of life, implement urban sustainability, and reduce CO2 emissions. Micro mobility is invading cities of all Europe becoming the next step of mobility in cities. Micro mobility aims to enhance customers which want to move quickly and easily through city streets avoiding traffic congestion. Another example is the Lime solution, a company that runs electric scooters in various cities around the world. "*Communities deserve access to smart affordable mobility*"¹⁵ as Lime's mission underlines, through the high distribution of electric scooters in all city area enable communities to connect people empowering urban living. Nowadays different cities are getting in the concept of smart mobility: it involves creating connected transport systems, which offer flexibility and efficiency. Mobility is a primary objective for cities striving to become smarter and more sustainable. Many cities around the world have already started to solve their transportation issues by implementing mobility-related innovations.

In 2016, Columbus Ohio won a challenge initiated by the U.S Department of Transportation by introducing the Smart Columbus Operating System (or SCOS). This operating system enables different options of decision-making for different areas of city life, from public transport management and traffic control to health care, water and waste management.

Moreover, Singapore uses a special platform called "Virtual Singapore" to organize mobility, health, productivity, and safety issues of the city. It allows city management to observe multi-system effects, for example how a new building affects the flow of traffic, or how parking regions develop. In Europe, various cities are facing an evolution in terms of smart mobility. As a matter of fact, Copenhagen is a world leader in eco-friendly initiatives and in the implementation of numerous smart city initiatives. The main project is "Copenhagen Connecting". The project deals with tracking connected devices,

¹⁴ Glasco, J., 2020. *Smart Mobility: Challenges And Solutions In Smart Cities*. [online] Hub.beesmart.city. Available at: <<https://hub.beesmart.city/en/solutions/smart-mobility/smart-mobility-challenges-and-solutions-in-smart-cities>> [Accessed 14 September 2020].

¹⁵ Li.me. 2017. *About Lime | Scooter And Bike Sharing Network For Cities And Universities*. [online] Available at: <<https://www.li.me/about-us>> [Accessed 13 September 2020].

including personal devices like mobile phones, and using the information gathered to optimize traffic, reduce congestion and thus reduce air pollution. Tracking devices with GPS provide a faster and easier solution for analyzing data. Through RFID tags, Copenhagen manages different elements like vehicles, bikes, and even home equipment, to prevent theft.

To make a smart city evolve, a smart government should be a pillar of it. The idea of an intelligent government administration is deeply intertwined with urban digital innovation. This should lead to great transparency and openness in administrative structures through digital participation using smartphones or computers. Smart government activities are mainly public participation, open data, ICT and E-government. An impressive innovative change has been done by the Estonian government. Estonia is the only country worldwide in which 99% of the public services are available online. E-services can't be possible only for marriages, divorces and real estate transactions. Through a comprehensive, sustainable and safe ecosystem, Estonia has obtained the highest level of transparency in governance and built broad trust in its digital society. As a result, Estonia has become a flourishing environment for business and entrepreneurship and, through its efficiency, saves more than 844 years of working time annually. Estonia has been one of the first adopters of converting public services into e-solutions for its citizens. The implementation of the Cloud solution for the government provides an excellent base for public e-services, which makes Estonia the most digital country worldwide. With the Cloud solution, Estonia is improving by expanding its ICT systems. Internet voting, or e-Voting, is a system that allows voters participate to in voting ballots from anywhere in the world. Moreover, Estonia's e-Voting system is a unique solution that simplifies and helps to engage people in the governance process. In 2005, Estonia became the first country in the world to use this method, and in 2007 was the first country to use e-Voting in the elections of the parliament.

Smart cities require smart people. People living in a smart city should address individuals' ability to develop their full potential and to engage in a high level of public and social participation. Consequently, the smart city conception emphasizes the application of digital technologies to encourage communication between inhabitants and to contrast the alienation that cities can foster. Overall the smart people dimension seeks to enhance open-mindedness, creativity, social and ethical diversity and affinity to engage longtime learning. Investment in human capital has been just as, if not more, important than technology in creating economically vibrant cities. The studies of Harvard's Edward Glaeser and MIT's Albert Saiz, for instance, demonstrates that education is the most reliable

driver of urban growth after a city's climate. "*The single best way to create a smart city,*" Glaeser writes in his bestselling book *Triumph of the City*, "*is to create schools that attract and retain able people.*"¹⁶ City leaders must work to balance investments in developing smarter infrastructures and utilities with investments in developing smarter and more innovative citizens.

Certainly, emerging technologies can help make our lives more efficient, more productive and more convenient. ICT and IoT are already challenging cities around the world into hyperconnected, ubiquitous networks that will enhance the welfare of the society. Nevertheless, smart things cannot replace smart people. Smart city investments are fundamental for urban living but without investing in citizens' capacity of maximizing the opportunities that the city of tomorrow will bring, there won't be a successful return. Smart infrastructure can help to facilitate value creation, but people are still the protagonists of the urban environment drama.

Smart Cities always have been emphasizing the role of technology but failed in long-term vision due to a lack of integration of citizens in urban life.

By using a people-centered approach, solutions would be created and implemented with an in-depth understanding by citizens. People-centered smart cities can be developed when citizens have the right consciousness of the possibilities that cities offer. Only by citizens consciousness cities can reach their full potential.

¹⁶ Talton, R., 2020. *Smart Cities Are Built By Smart People, Not Smart Things*. [online] Forbes. Available at: <<https://www.forbes.com/sites/ellistalton/2019/07/09/smart-cities-are-built-by-smart-people-not-smart-things/#3fb390c075d6>> [Accessed 14 September 2020].

Chapter 3: The Smart City Management Model

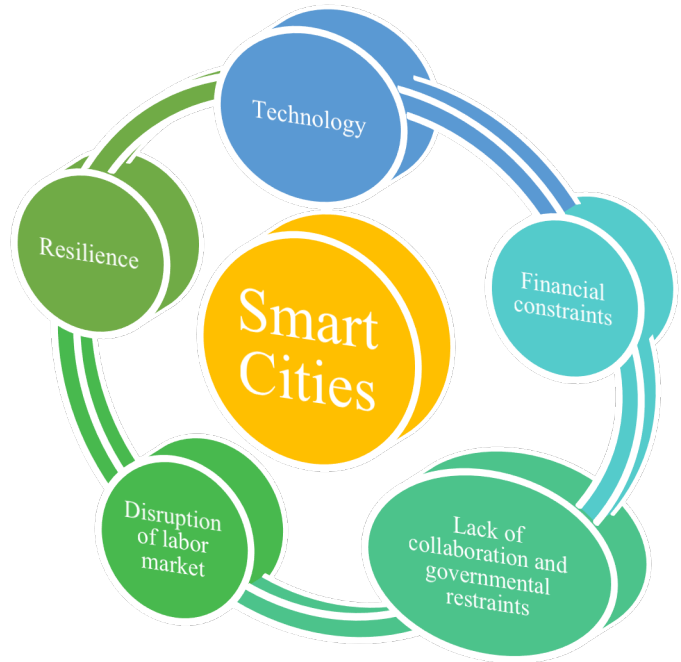
3.1 Smart cities most common challenges

Different challenges are faced by smart cities. The faster the cities evolve, the more limited our practical knowledge becomes. Cities are enormously suffering from the external environment which complicates the launch of new initiatives. These challenges inspire partners, managers and city leaders to come back up with innovative solutions.

The challenges that might encounter managers include:

- 1) Technologies challenges: Smart city projects depend extremely on technology. However, implementing digital infrastructure is challenging because of a lack of information about ICT systems, software, and security which create problems due to privacy settings and hacking. Moreover, Smart cities are highly digitized cities by nature, characterized by large volumes of data stored digitally and huge numbers of physical objects with a connection to the Internet. This can be employed positively, by contributing to societal goals, but it is also possible to abuse the possibilities for criminal purposes.
- 2) Financial constraints: Smart city projects need compelling financial resources to adapt technology to the existing city infrastructures. This operation is more expensive than building a new smart city from the beginning. The main challenges are the research of lenders which will finance initiatives, choosing the proper investment that may create long-term efficiencies, benefits and return, the tendency to deflect investments that will generate long-term benefits and that specialize on short-term and therefore the desire of making innovative businesses.

Figure 3.1 Smart cities most common challenges



3) Lack of collaboration among different stakeholders and governmental restraints:

One of the pillars of smart city initiatives is a collaboration among private organizations, public institutions, NGOs, citizens, etc. The main challenges are weak communication among partners and coordination among these participants, lack of policies for open data that enables sharing across departments and organizations, lack of support from both local government and city administration and the time taken by organizations involved in the project to make decisions.

4) Disruption of the labor market: One of the arduous challenges dealing with smart cities is the irreversible disruption of the labor market, due to automation and the use of robotics to replace manual work. Disruption of the labor market is one of the major concerns. Due to disruptive technologies, many existing jobs will disappear with unemployment as result. People will have to learn and to train in 21st-century skills more quickly to remain employable. The city has to make this transition as smooth as possible by evolving rapidly and making the turn faster. As a matter of fact, researchers of the University of Oxford have analyzed the impact of computerization on 700 jobs. For each job, the researchers estimated that some of the jobs existing now will be fully computerized in the next 10 to 20 years. The results were evident: 47% of total employment has a high probability of disappearing due to computerization. Consequently, the pace at which existing jobs disappear and people become unemployed also increases. If people, as the environment changes, do not adapt, large structural unemployment will be the result.

5) Resilience: *“The ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions due to deliberate attacks, accidents or natural threats.”*¹⁷. Resilience is considered one of the words that have influenced the last decade: by being resilient, someone is capable of withstanding shocks without permanent rupture and tends to recover from or adjust easily to changes. 'Being resilient' means cities that can last, when they are through crises, possessing inner strength and can resolve. One of the consequences of digitalization is an increasing dependency on digital technologies. If digital infrastructures suddenly start to have problems or some unexpected arrest, lead to could serious disruption of society and the economy. City resilience is about ensuring continuity of services (such as electricity, water, communication, transportation, etc.), that are increasingly becoming dependent on inhabitants and for smart cities. The task of the cities is to preserve and protect services that can highly be influenced by a rapid drift of technology base. Moreover, when a crisis arises, information is the key in order to make the right decisions. A smart city supports city government and management whenever crisis management occurs, by providing

¹⁷ Nrel.gov. 2020. [online] Available at: <<https://www.nrel.gov/resilience-planning-roadmap/pdfs/defining-resilience-exercise.pdf>>

detailed and real-time information and analysis tools that may help predict the consequences of different possible decisions and strategies.

3.2 Success factors of smart city initiatives

In order to enrich every smart city, a comprehensive set of success factors that are essential to understanding smart city initiatives and projects. Through the examination of benefits, a city can truly understand its value and long-term benefits. These different clusters of factors are the key by which smart cities can target.

-Stakeholder benefits:

A strategy with clear benefits that leads to individual benefits to each stakeholder is a success factor. Gathering continuously responses by stakeholders, will lead to a collection of data and to understand the trend of satisfaction of stakeholders. A strategy based on real needs is more likely to have a measurable outcome.

-Engagement and Buy-in

Engagement is connected to one of the three layers which define a smart city, the citizen connection. Smart City is anchored in a well-founded connection with its people. This overarching pillar is crucial in the success of the strategy of a smart city as it will inform the budgets, and impact acceptance during implementation. Fundamentally the connection begins with the development of the strategy through the engagement process, including businesses, residents, and special interest groups.

-Regional alignment with community

Smart cities should highly focus on reinforcement of collaboration with regions and among regions. To create continuity of services among regions a clear strategy should be applied, in order to address the objectives in one single direction. This is important for keeping a vision of customer-centric base, focused on enhancing the citizens and their quality of life, thus, on improving business development.

-Clarity

In order to obtain results based on smart city initiatives, it is important to spread with clarity to all citizens and businesses the solution offered. Public messaging and branding are the right key to support the focusing of initiatives and to underline the key reasons why undertaking these new projects.

-Lessons learned

The projects implemented for a smart city initiative are mostly new ideas, which have taken different forms and approaches. Although, without learning how it has been done in the past, it is difficult to approach with a new disruptive idea. History has embedded all the successes and failures that can easily income. By sharing knowledge and connecting people, more consciousness might be reached.

-Urban integration

The integration of technology applications within the public realm is an emerging trend in most cities all other the world. Urban integration is functional in improving the quality of life for citizens. The best technology deployments are those that provide welfare for the community, are not tangible in the public realm, and are applied with a long-term vision. Through the development of urban integration, smart cities will ensure that the technology and the built environment are happening at the highest level.

-KPIs

While many specific initiatives will be quantifiable, most of the expected results may be less measurable. Thus, there are several Key Performance Indicators (KPIs), that have been implemented by organizations such as ISO (International Organization of Standardization) and ITU (International Telecommunication Union), through the UN. The UN's United for Smart Sustainable Cities (U4SSC) initiative, coordinated by the ITU, provides the guidance necessary to address cities along their smartness and sustainability pathways. U4SSC helps cities to exhibit their performance through the Key Performance Indicators (KPIs) for Smart Sustainable Cities (SSC). The KPIs for SSC consists of 91 indicators. Each U4SSC KPI has been selected through a process of review and input by international experts and UN agencies to capture a city's performance and value in three dimensions: Economy, Environment and Society and Culture. Through this framework that enables both top-down and bottom-up analysis, the U4SSC KPIs introduce each city's smartness and sustainability. Each of these three dimensions underlines a different point of view that, reported all together, collect a holistic view of a Smart Sustainable City.

-Creating a lasting Smart City culture

One of the reasons that many cities invest time in developing Smart City initiatives is to optimize and integrate the implementation of ICT within the organization. The involvement of all relevant stakeholders is the key to creating a culture of buy-in that goes beyond the initiatives itself. The

successful coordination and sharing of challenges as part of the Smart City governance are the key for a long-term and profitable success. While large cities have a potentially larger tangible benefit from Smart Cities initiatives, smaller cities also reflect a strong position on creating a sustainable ongoing culture of innovation.

According to Bolman and Deal's "Reframing Organizations", culture is one of the most important frames to include in a range of lenses by which any manager or leader should apply in an everyday situation. Moreover, culture becomes discernible as a unique and shared identity of society. In addition, dealing with Bolman and Deal "Reframing Organizations", "*Culture forms the superglue that bonds an organization, unites people, and helps an enterprise to accomplish desired ends.*"¹⁸

3.3 Smart City Management Model

As cities are evolving day by day, a suitable business model would be the right key for the correct management of them. Business models have often failed to navigate the complexity of urban system solutions. Failure arises for two main factors: firstly, sustainable smart cities solutions create value for the realm of external costs. If this value is not implemented by a business model, these external costs cannot represent at its best economic value when comparing different solutions. Secondly, the complexity of the solutions requires the management of them by developing, adjusting and implementing the different solutions provided. A business model would reduce the probability of mismanagement and a lack of balanced distribution of costs and benefits.

Furthermore, Smart Cities mostly are emphasized for technology implementation and their interconnection. Most of the people ignore that smart cities without the core of a structured plan cannot be implemented. The "digital shadow" is necessary for an interconnected city, but the essence of the plan is an underlying business model, which illustrates how value is created for a product or a service and how this value can be exploited. One of the most difficult challenges for a smart city is the lack of a clear idea around which decisions are taken. A reference of frame should be implemented in order to enable individuals to keep track of several topics and to structure a time sequence of projects. According to research conducted at the University of St Gallen, researchers have developed a Smart City Management Model, which provides the reference of frame by which can implement ongoing projects in cities and can deliberate value for future projects. It enables Smart cities to address any project towards different dimensions.

¹⁸ BOLMAN, L., 2017. *REFRAMING ORGANIZATIONS*. [Place of publication not identified]: JOHN WILEY & Sons.

The SCMM collects three essential dimensions of changes:

- the service areas (depicted at the center of the diagram);
- the transformation processes (illustrated as a cycle);
- the fundamental elements.¹⁹ (which encompass the other two dimensions)

The SCMM is based on the experience of smart city lighthouses and the future vision of the city. A smart city affects the entire living system in a city such as economy, environment, mobility, etc. Cities in order to pursue transformation should embrace and implement each field of life. At the center of transformation, there are smart city service areas that are linked with the objectives and the current situation of each city.

As previously remarked, these service-areas are smart environment, smart living, smart economy, smart mobility, smart government and smart people. In order to understand and improve these service areas, it is important to identify internal and external structuring elements for the transformation process. The transformational process mostly undergoes the same cycle from the beginning to its end. Moreover, it encompasses different steps:

1. Determine location;
2. Develop concepts and select partners;
3. Activate resources;
4. Realize projects;
5. Operation and instrumentation.

By applying this process chain, cities can be managed in order to achieve their goals: concrete realization ideas are conceptualized, locations are analyzed, and a sustainable plan is depicted. Consequently, having tangible ideas, the abstract vision is supported by an implementation-oriented

Figure 3.2 The Smart City Management Model



¹⁹ Source: Gassmann, O., Böhm, J. and Palmié, M., 2019. "Smart Cities: Introducing Digital Innovation"

vision. In this process, project realization occurs thanks to mobilized resources. At this point, most of the costs and resources decisions arise and most of the practical issues hurdle.

A final and pragmatic solution should be the next step through operation and anchorage of initiatives so to ensure a lasting impact. Furthermore, the basic elements which embrace all the management model are relevant for all smart city initiatives and are important for a smart city transformation.

There are six basic elements which define the realization of ideas:

- partner and city participation;
- financing;
- technology;
- business model;
- communication;
- data governance.

All of these initiatives are possible if they are all oriented to the inhabitants of the city. People must interact positively with every change and initiative to expand and flourish the wellbeing of a city. As a matter of fact, inhabitants should highly participate in the dynamic environment of a city. In this case, stakeholder engagement and communication skills through a deep consciousness of media, have central importance for success.

Indeed, financing of initiatives must be particularly observed in order to ensure successfully achieve lasting developments. There are different ways by which a smart city can finance its developments. Each financing operation should be confronted with the life cycle of the idea to be financed.

Smart cities are generally strongly driven by value creation potentials which are mostly enabled through the consciousness of technologies.

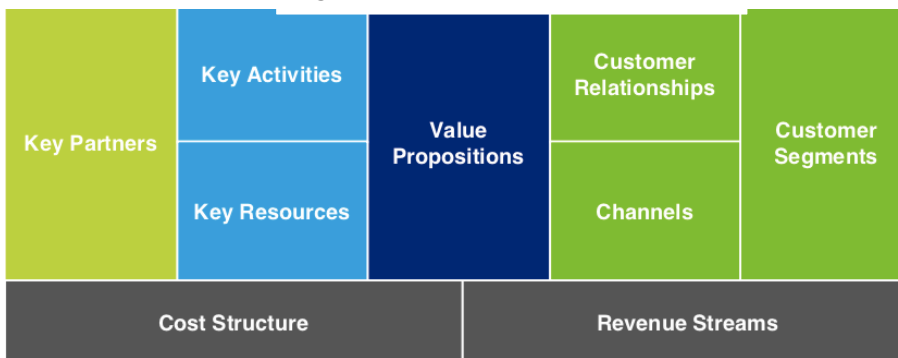
A profound understanding of these technologies, their areas of application and the path dependencies of them should be analyzed for each initiative. Thanks to the collaboration of partners and the collaboration of the inhabitants of the city, initiatives can highly represent a positive drift towards the future. Through innovative digital business models, smart cities can create entirely new customer value and revolutionize the concept of business model. A right suitable business model should collect long term and sustainable operations, for instance, projects as the lighthouse project. Moreover, through an observed collection of data, business models can accurately select and organize information. The more infrastructures such as public transportation, water supply, and telecommunications get digitalized, the more data governance represents a crucial element of smart city thanks to the reliability of the information collected. The digitization enabled by Smart Cities

enhances the foundation for new business model possibilities, creating new customer value. However, these new business models should offer a long-term and sustainable value that is aligned with the objectives and goals defined for a Smart City.

3.4 Smart City Business Model Canvas

According to Alexander Osterwalder & Yves Pigneur’s “Business Model Generation”, Business models are functional to define the environment. “*The business model is like a blueprint for a strategy to be implemented through organizational structures, processes, and systems.*”, as demarked in “Business model generation”. “*Smart cities are not an isolated phenomenon but an integral part of a broader transition towards a digital economy.*”²⁰, It is important so to define the pillars of the business model canvas to better implement Smart cities. The term business model is usually employed in social innovation environments and it has also been used for employing technology to create and capture value.

Figure 3.3 Business Model Canvas



Starting by value propositions, Smart cities are required to answer the question: “what do you do better than others?”. As a matter of fact, the value propositions in smart cities are a bundle of services that create value for citizens. These last ones are different groups of people or organizations or an enterprise, which aim to reach, serve, to address targets and to implement initiatives. Moreover, the Channels are used to describe how organizations communicate with and reach their citizens to deliver values. Dealing with smart cities, the costumers to reach are properly the society and the citizens. Citizens are fundamental for the correct functioning of the initiatives process. Customer Relationships deeply influence the overall “citizen” experience.

In order to better embrace the citizens and the society, initiatives and activities should be correctly done. Every business model calls for a number of Key Activities, which are the most important

²⁰ Osterwald and Pigneur, 2018. *Business Model Generation*. 1st ed.

Figure 3.3: Source: Smart Cities How rapid advances in technology are reshaping our economy and society, Deloitte Analysis

actions a city must take to operate successfully. As well as Key Resources, they are required to create and create a Value Proposition, foster “citizen” relationships, and earn revenues. However, it is important to create and enhance partnerships all over the different services a smart city can offer. Partnerships are fundamental to make a city interconnected through each service.

Nonetheless, cost structure and revenue streams are fundamental to understand the benefits a city could achieve from entering each initiative and project. As already underlined, smart cities are highly impacted by social and environmental influence. Thus, there should be taken into consideration the social and environmental impacts, losses and benefits. Having a clear idea of each building block of the business model canvas can represent clarity to future initiatives.

3.5 Smart City Case Studies

Several cities have been considered innovative for their dynamic perspective and urban development. Analyzing two of the cities that nowadays are leading the smart city world by a European perspective, such as Stockholm and Barcelona, I would like to point out the process and initiatives they have applied to become smart cities.

To facilitate the comparison among cities, the Smart City Management Model (SCMM) is taken into consideration.

3.5.1 Barcelona

Barcelona, known as the first European Capital of Innovation in 2014, is nowadays trying to establish its supremacy by leading in the sector of digital infrastructures in collaboration with a stimulating environment such as the city and the inhabitants of Barcelona. For 30 years, Barcelona has underlined the importance of development and innovation. Nonetheless is the birthplace of high-tech industries, startups, and knowledge-intensive hubs. When Cisco Systems in 2011 has focused on this city, the term “smart city” wasn’t so used, while instead now is one of the most important smart cities of the world. Today Barcelona is focusing on its smartness not only by the IoT point of view but even a city for people. It is a city capable of changing radically its objectives and vision, restoring power to technologies and control to citizens.

Figure 3.4 Barcelona Smart City initiatives



Vision and strategy

In the last decades, Barcelona has been highly focused on the digitalization as its primary element for the modernization of the city.²¹ Since the establishment of the mayor Xavier Trias, the vision and the strategy have changed, basing them towards the e-government and a more open perspective of the smart city. The idea was generating an “economy of urban innovation” that should help the city to create an urban reality based on auto-sufficiency, hyper-connectivity and zero emissions.

The three strategic axes were initially three:

the first regards the systematization of the smart projects, identifying new opportunities and new threats and understanding new areas in which citizens can achieve benefits.

By this logic are identified different vertical silos (most focusing on e-government and smart mobility), but most of all infrastructure implementation such as: optical fiber, high sense integration and open data network.

The second axes on which concerns Barcelona Smart City is the high value of the city as the city of reference for every digital scope: as a matter of fact, from 2011 Barcelona has encouraged digitalization through fairs such as World Smart City Expo and Mobile World Congress.

Lastly, the third ax coincides with the enhancement of international collaborations, promoting City Protocol Society, a network of the city in partnership with universities and businesses to define the smartness of its cities. In 2016 it has been published a new project, “Barcelona Ciutat Digital”, that doesn’t focus on technologies with the objective of an auto sufficient and efficient city but a comprehensive city open to citizens. New axes have been analyzed, but with a new key to framing the city in a more local perspective.

The first is “digital transformation”, by which technology is used to lead to more transparent and accessible management, giving power to citizens. By a “digital innovation”, the city strives the

²¹ Source: <https://smartcityhub.com/technology-innovation/barcelona-showcase-smart-city-dynamics/>

creation of an ecosystem of startups, new businesses, robotics and digital platforms. Lastly though, “empowerment of citizens”, is used to focus on the future of working and of learning. Nonetheless, this new perspective collocates citizen participation in innovation and development as its primary objective.

Implementation

The top-down approach characterized by clear coordination within the city management and a link between the political and management level (helped by the fact that Barcelona Smart City was a direct reporting of the Mayor) did not give space to third-party actors at the strategic level, however, it has facilitated its involvement at the operational level, influencing positively the ability to build the smart city. Indeed, the result orientation and the political will of the administration to make the city an urban laboratory for technologies, combined with an already advanced infrastructure of the city, have attracted public and private investment. Of particular importance were the public-private partnerships with hi-tech companies, such as Cisco, Microsoft, IBM, but there were collaborations with universities and research centers. In the vision of the Smart city department, the partnerships with the hi-tech enterprises foresaw the condition that the created technologies were in open-source modality and not of property, stimulating therefore new models of business. In fact, despite not being able to gain from software improvements, companies were able to use Barcelona as a laboratory to optimize their products and then sell them in other urban contexts.

Although hi-tech companies remain a key element, the modalities of their involvement have been strongly criticized by the new junta, which refuses to make Barcelona "a showcase where large companies can showcase their products" Instead, it wants to find "solutions to urban problems", without imposing technologies, but a tool. In this we do not want to ignore the smart city legacy left by Trias, but rather change the perspective. In fact, as mentioned, the city of Barcelona is now moving in a logic of co-production of smartness with citizens.

In this, a penalizing element was the lack of a "common layer", an open system of organic analysis, integrated and functional data collected by Sentilo, the multisectoral sensor platform. Towards the end of the mandate, the Trias junta had opened a call for the definition of Cityos, an open-source platform for the analysis of all public data. However, it is with the new junta that the Mobile World Congress 2017 was presented the preview of Cityos, expected to be operational from 2019 with a user interface to facilitate access to data. In conjunction with the efficiency of the use of data, we have moved in the direction of democratization of the same with the project DECODE: the new platform and the data it contains will be available to individuals and third parties interested in

developing apps and services for the city, but citizens are given ownership of the data, the choice of what information to share, the privacy rules and how to use. The Barcelona model, which unites the two administrations, has a further impact on implementation capacity, namely the availability of high-level financial resources and expertise at the start of the initiatives. As for smart investments, the numbers are presumably considerable, although not systematized and therefore difficult to aggregate into a single figure. In general, the Municipality expected expenditure of 120 million euros between 2012 and 2015 for its digitization only. In the following years, the expenditure for the digital transformation of the Public Administration has further increased and is expected to 48 million euros in 2018 alone, in addition to which, in line with the objectives of the Colau junta, investments in participatory democracy for 61 million (up from 45 in 2015).

In addition to the ordinary resources of the Municipality, support on public-private partnerships allows a financial mix useful to ensure the sustainability of the initiatives in the medium to long term. For example, in 2014, Cisco and Schneider announced 37 million euros in 5 years for the renovation of the Ca l'Alier industrial building within 22@Barcelona, one of the most important projects being expected to cost 180 million euros in total⁵¹. In addition, the Barcelona Smart City project has benefited from European funds, such as the approximately 600 thousand euros in the ERDF 2007-2012 programming and the 500 thousand euros for the iCapital 2014 award.

Concerning skills, it is useful to stress in particular how the choice of people in charge of smart city strategies strongly reflects the orientation of the two juntas. Julia Lopez, the coordinator of Barcelona Smart City, came from experience as Chief Information Officer of the City, therefore with a predominantly IT background. In line with the logic of the new junta, however, the Barcelona Ciutat Digital plan is currently headed by Francesca Bria, coordinator of the European D-CENR project on direct democracy, Digital Social Innovation in Europe project researcher and member of the European Commission's Open Innovation Expert Group.

3.5.2 Stockholm

Sweden, as a technologic and innovative country, is one of the world-leading companies and expertise in the fields of research and innovation within many areas. The City of Stockholm (Sweden) was recognized as the world's smartest city during the Smart City Expo World Congress in Barcelona last November. Stockholm is a leader in the European Smart Cities and Communities project GrowSmarter. Gustaf Landahl, the Project Coordinator for GrowSmarter and Head of Department

for Planning and Environment in the Environment and Health Administration at the City of Stockholm, announced when accepted the prize: *"As a representative of the City of Stockholm and also the GrowSmarter project, this award acknowledges what we have done in Stockholm for many years."*²². Different solutions have implemented Sweden in order to denominate Stockholm as the smartest city nowadays. By implementing smart and sustainable solutions from Sweden, a sustainable society, that does not contribute to a rise in CO2 emissions, Stockholm is a pillar of technology development.

Sweden through innovative solutions within the energy, waste management, mobility, and many other areas related to sustainable development, represents a sustainable country. By using solutions such as waste to energy systems, waste is then reused as a renewable and environmentally safe energy source.

Moreover, Stockholm as a smart and connected city, in collaboration with the City of Stockholm's employees, residents and businesses has developed a new, sustainable strategy. The City of Stockholm in April 2017 has adopted this strategy based on gender equality, widespread IT infrastructure, and high digital maturity, as well as the opportunities of digitalization and new technologies.

The core of the strategy's target vision describes the goal of the strategy and the City's digitalization efforts: to implement a higher quality of life for inhabitants and a better entrepreneurial climate.

Figure 3.5 Stockholm's Smart City initiatives

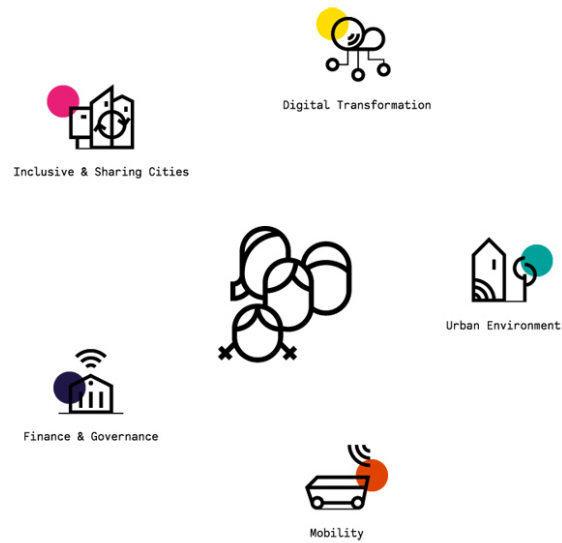


Figure 3.6 Stockholm smart city strategy



²² Cordis.europa.eu. 2020. *CORDIS | European Commission*. [online] Available at: <https://cordis.europa.eu/article/id/411609-stockholm-wins-world-smart-city-awards-for-european-project>

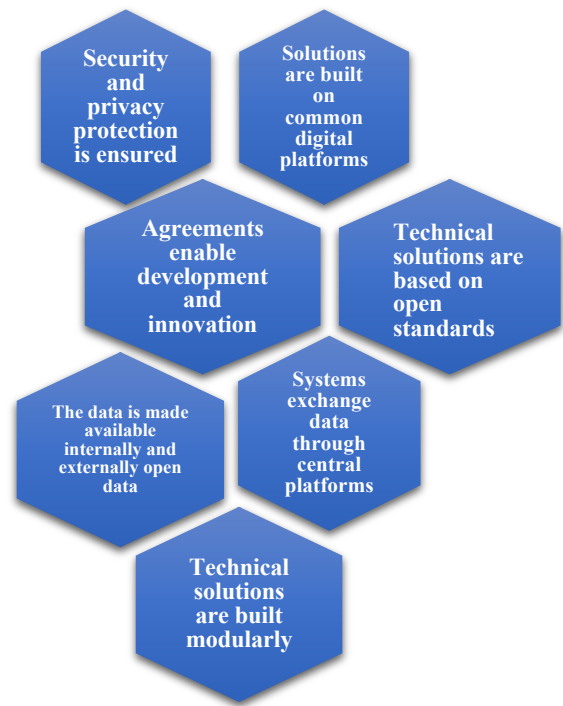
Figure 3.5: Source: https://www.smartcitystockholm.se/smart-city-summit?sc_lang=en

Figure 3.6: Source: <https://international.stockholm.se/governance/smart-and-connected-city/strategy-for-a-smart-and-connected-city/>

Through solutions, based on innovation, clarity and connectivity, the city of Stockholm has provided a more socially and economically sustainable city.

Having developed areas such as IoT, Big data and ICT systems, Stockholm has implemented new services and features. This implementation has led to the development of digitalization. As a matter of fact, “The smart city is made possible through connectivity and open data, integrated platforms, sensors and other technologies”, as announced by the city of Stockholm Guidelines. To enhance this strategy, different enabling factors are taken into consideration. There are three main areas in this strategy: operations, technologies (as already underlined) and relative cost distribution. In order to pursue the best from the strategy taken in consideration, seven strategic principles have been developed for the city.²³

Figure 3.7 The seven Principles of Stockholm Smart City



These seven principles enable the Smart city of Stockholm to enhance the profitability and well-being of inhabitants. The seven principles are a vital tool for obtaining digital sustainability. Digital sustainability refers to solutions being designed so that is employed in the long-term, cost-effectively and which are easy to incrementally develop, reuse, and connect. Moreover, a conscious usage of these principles can lead to a more sustainable and interconnected city.

Implementation

The implementation of the strategy consists of three main areas: coordination and collaboration (internally and externally), communication with inhabitants, as well as prioritized projects. The core of the strategy is based on applying initiatives that will be implemented contemporarily with different projects, as legal and organizational projects. According to the strategy’s vision, this implementation

²³ Source: <https://international.stockholm.se/governance/smart-and-connected-city/strategy-for-a-smart-and-connected-city/>

is the key to a smarter city sustainably.

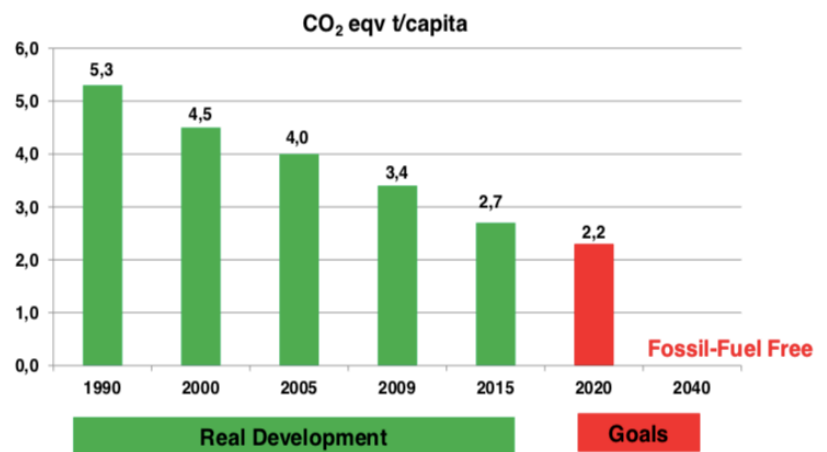
Furthermore, initiatives should also have good feasibility, be long-term, scalable and assessed to provide great benefits and impact on one or more target groups.

In the last years, the GrowSmarter project has thrilled the City of Stockholm and its inhabitants.

According to the main objective of this

project, Stockholm in 2040 should become a cohesive climate-smart, financially sustainable and a democratically sustainable city. As a matter of fact, the City of Stockholm owns the world's largest open fiber network (more than 5500 kilometers of fiber cable long). According to the ambitions of the "Stockholms Stad", in 2040 Stockholm will be fossil fuel free.²⁴

Figure 3.8 Stockholm goals and objectives



3.5.3 Stockholm and Barcelona: Lighthouse cities

Both Barcelona and Stockholm, through a strong communication approach, have become two of the smartest cities in the world. As a matter of fact, the two cities have implemented a new project called GrowSmarter: it brings together the city of Stockholm and Barcelona. These cities all together implement smart solutions with industrial partners towards a better lifestyle to their citizens. Moreover, Stockholm has been leading the GrowSmarter project since the beginning of 2015. The project is funded by the European Union through the Horizon 2020 Research and Innovation program and connects cities and industries to integrate and demonstrate "12 smart city solutions" in energy, infrastructure and transport in order to enrich the city welfare and sustainability. Together with the other 25 partners, the project deals with smart technologies related to low energy districts, integrated infrastructures and sustainable urban mobility in chosen sites. The objectives are to gather advanced information from ICT systems and to create better smart mobility incorporating renewable energy sources directly into the city's supply network.

Furthermore, both cities are defined such as "lighthouse cities" as well. A lighthouse project is a short-term and determined project that is used as a model for over projects. These two cities are a clear example of lighthouse cities. The lighthouse cities as Stockholm together with partners are

²⁴ Figure 3.8: Source: <https://www.climateneutral.eu/wp-content/uploads/2017/01/6-Smartcity-Projects-in-Stockholm-oct-2017.pdf>

implementing and evaluating the solutions for energy efficiency, greenhouse gas saving capacity, economic viability and economic impact and replicability. These solutions are in line with the cities' urban strategies and plans.

The solutions are divided into three different sections:

-Low energy districts: Efficient and smart climate shell refurbishment, smart building logistics and alternative-fueled vehicles, smart energy-saving tenants through information and smart local production of electricity and integration with power grid;

-integrated infrastructures: smart lighting, lamp & traffic-posts as hubs for communication, waste heat and local heat integration by new business models, smart waste handling turning waste to electricity, heat and biogas for vehicles and Big data protocol for saving energy and improving the quality of life;

-sustainable mobility: sustainable delivery, smart traffic management, alternative fuel-driven vehicles for decarbonizing, better air quality and smart mobility solutions.

Conclusions: What's next for Smart Cities?

As already remarked, the UN has predicted that by 2050, two-thirds of the world population will live in cities. As far as we have seen, cities are the future and to have the possibility to create a sustainable ecosystem, cities should work smarter and not harder to serve their citizens.

Smart cities are a dynamic and flexible environment that can highly enhance the quality of life by investing in technologies. The biggest prediction is that the term “smart city” will soon be replaced by the “contemporary city” as more and more cities implement smart technology into everyday life and will be usual to have cities operated by IoT sensors and artificial intelligence.

Different solutions have been provided for the future of cities: interoperability, 5G solution, IoT sensors, public safety, and human-centered design.

Interoperability is the matter by which city infrastructures, that already have been partly rendered smart within each city limits, should be all connected. These matters with buildings, cars, sensors, devices and applications that all together in an interoperable unit could achieve goals and be helpful for each other work and so, working together for a purpose.

Secondly developing 5G networks will be fundamental for smart cities. Its faster connectivity and its greater potential to the society could leverage costs and support a broader range of opportunities.

According to the deployment of IoT sensors, more and more cities that will implement and invest in sensors can facilitate the transmission of data. IoT sensors will be part of our everyday life: they will be placed at bus stops, parking, on garbage cans, roads and streetlights to provide simultaneous information dealing with traffic, crowds and more.

Moreover, another pillar of future solutions for smarter cities is public safety. As already specified, streetlights system improvement is connected with the safety of preventing accidents or aggressor incidents. Detection systems will be applied in each streetlight and though this system can be detected even gunshot and shooter detection.

Lastly, the first goal and objective are human welfare and citizen quality of life. Technologies are fundamental but is not all about implementing technologies for the sake of adopting new technology. Implementing a smart city initiative will be easier and more comprehensive if collaboration among industries, cities and local governments is intensified. Cities, in order to develop a plan of innovation that leverages the overall costs and improves the lives of citizens, should apply different management frameworks and deploy all its focus on sustainability solutions.

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